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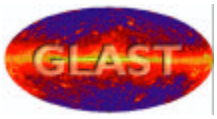
	*GLAST LAT CAL* *Mechanical Structure*	Ref :	GLAST-LLR-SP-035
		Rev :	D
		Date :	October 21, 2003
		Page :	1

Specification :
Cutting and Layup of the Composite Fabric Plies

SLAC reference :

English Translation of Original Document for Reference Only

Liste des modifications

D	21 Oct 2003		O. Ferreira S. Le Quellec	P. Poilleux	S. Le Quellec	O. Ferreira
C	22 Sept 2003	Modification des cotes de découpes (nouvelle version des plans)	S. Le Quellec	P. Poilleux	S. Le Quellec	O. Ferreira
B	12 mai 2003	Ajout spécifications des empilages + modifications du nombre de découpes et des dessins	O. Ferreira S. Le Quellec P. Poilleux	P. Poilleux	S. Le Quellec	O. Ferreira
A	26/06/02	**CREATION**	S. Le Quellec	P. Poilleux	L. Meslier	O. Ferreira
Rév.	**Date**	**Modifications**	**Auteur**	**Vérificateur**	**Validation AP**	**Validation chef Projet**

Table of Contents

List of Acronyms

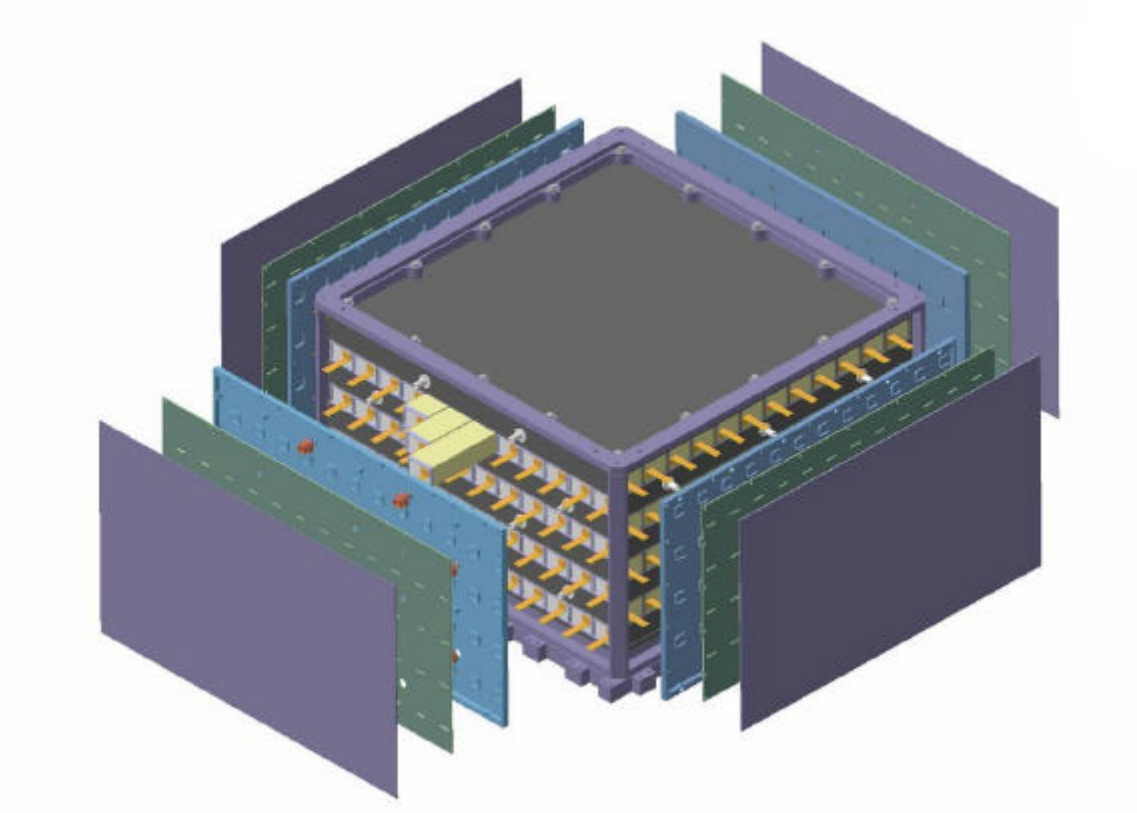
CEA	Commissariat à l'Energie Atomique
CNRS	Centre National de la Recherche Scientifique
DOE	U.S. Department of Energy
GLAST	Gamma-Ray Large Area Space Telescope
LLR	Laboratoire Leprince-Ringuet
NASA	National Aeronautics and Space Administration

1 INTRODUCTION

1.1 PRESENTATION

The LLR (Laboratory Leprince-Ringuet) is a laboratory of IN2P3, the department of nuclear and particle physics of CNRS. Its activities cover the experiments of astrophysics and particle accelerators, both ground and satellite-based systems. The GLAST project is one of these experiments. It is an international cooperative project between the National Aeronautics and Space Administration (NASA) and the Department of Energy (DOE) of the United States and the Centre National de la Recherche Scientifique (CRNS) and Commissariat à l'Energie Atomique (CEA) of France.

The LLR has the responsibility for the study and the development of the mechanical structure for the Calorimeter (CAL) subsystem of the instrument. The CAL subsystem consists of 16 modules, each containing CsI crystal bars, which emits light when they are crossed by the cosmic radiation. These crystals are coupled with photodiodes and read-out electronics, which read and acquire the signals. The mechanical structure of each module consists of a cellular composite structure, which support the crystal within the cells. Aluminium parts provide close-out of the crystals in the cells, electromagnetic shielding of the electronics and an interface with the other instrument subsystems.



1.2 OBJECT

The purpose of this document is to define the requirements and the precautions necessary to handling, cutting and the stack-up of the plies of the pre-impregnated fabric used in the manufacture of 18 composite structures.

The subcontractor will be responsible for meeting the requirements of this document. Any variation from these requirements will not be permitted without prior agreement with the LLR.

2 ASSOCIATED DOCUMENTS

Titre	*Référence*	*Vers*	*Date*
Following card for the roll of pre-impregnated fabric	GLAST-LLR-FS-XXX		
ES1 Top Stack-Up 1	GLT-LLR-31-01	A	30/06/03
ES2 Top Stack-Up 2	GLT-LLR-31-02	A	30/06/03
EI1 Lower Stack-Up 1	GLT-LLR-31-03	A	30/06/03
EI2 Lower Stack-Up 2	GLT-LLR-31-04	A	30/06/03
ELA Side Stack-Up A	GLT-LLR-31-05	B	15/09/03
ELB Side Stack-Up B	GLT-LLR-31-06	B	15/09/03
ELAB Side Stack-Up AB	GLT-LLR-31-07	B	15/09/03
PEN Mandrel Wrapping Ply	GLT-LLR-31-08	B	15/09/03
PIN Vertical Interior Ply	GLT-LLR-31-09	B	15/09/03
PHI Interior Horizontal Ply	GLT-LLR-31-10	A	30/06/03
PLCA Side Layer Ply – Type A	GLT-LLR-31-11	B	15/09/03
PLCB Side Layer Ply – Type B	GLT-LLR-31-12	B	15/09/03
PEC External Layer Ply	GLT-LLR-31-13	B	15/09/03
PEAK Interior Layer Ply	GLT-LLR-31-14	B	15/09/03

3 MANAGEMENT OF PRE-IMPREGNATED FABRIC

3.1 SPECIFICATIONS OF PRE-IMPREGNATED MATERIAL

Pre-impregnated composite fabric is a product manufactured by HEXCEL Composites, USA. It is composed of a high strength carbon fiber fabric pre-impregnated with epoxy resin. Its reference is T300 1K PW/M76; 40%; 124 AW; 42".

- Fabric
    - Fibers T300 1K
    - Taffeta Weave
    - Mass 124 g/m²
- Resin
    - Epoxy M76
    - Resin Content 40 % mass
- Average thickness of a ply: 0,12 mm based on 60% fiber content

3.2 PROCUREMENT OF PRE-IMPREGNATED

The LLR has the responsibility for purchasing the pre-impregnated fabric at HEXCEL Composites and will ensure its delivery to the subcontractor. Total surface of the product is 500 m² and will be delivered as a single lot.
The product is provided in 30 cm diameter rolls of approximately 1.20 m in width. Each roll contains approximately 50 m² of pre-impregnated fabric. Twelve rolls will be delivered. The subcontractor must have a sufficient storage capacity at -18°C to store them.
The subcontractor will be responsible to manage the stock of pre-impregnated fabric. He will set up a suitable procedure which will have to be validated by the LLR. The subcontractor will be responsible for any degradation of the pre-impregnated fabric.

The surplus of pre-impregnated fabric will be returned to the LLR according to the Section 7.3.

3.3 GENERAL PRECAUTIONS OF USE

- The pre-impregnated fabric has a shelf-life of one year when it is stored at low temperature (-18°C) and **21 days at room temperature**. Therefore, it is imperative that the material is hermetically sealed and stored at -18°C whenever the delay between two fabrication stages is greater than 48 hours.
- Since lay-up will follow cutting and stack-up, **pre-impregnated fabric must not in its thawed state more than 10 cumulative days** at the subcontractor.
- Since pre-impregnated fabric cannot tolerate moisture, it is essential that the material is sealed before refreezing.
- The sealed packaging of the pre-impregnated fabric should never be opened before the product reaches ambient temperature. To prevent condensation from forming on its surface, the package is wiped with a dry cloth. If condensation reforms on the bag, it should not be opened until the product reaches room temperature.

3.4 RECEPTION OF PRE-IMPREGNATED FABRIC

The LLR will be responsible for the receipt of the pre-impregnated fabric at the subcontractor facility. LLR will be responsible for receiving inspection of the product and will provide the associated report. The following requirements are to be verified:

- **Conformity**
  LLR will verify that the product is in conformance with the specifications and that the delivered quantity is correct. Verification of conformance will be limited to checking the documents provided by HEXCEL Composite.
- **Documents**
  LLR will verify that the certificate of compliance and the verification reports, which includes detailed inspection of the rolls (describing defects and defect location), were delivered with the product. Verification is performed per the pre-impregnated fabric procurement specification GLAST-LLR-048.
- **Packing**
  LLR will verify that packaging of the pre-impregnated fabric rolls is in good condition with no apparent deformation, trace of shock or moisture, and that the rolls are vacuum-packed and hermetically sealed. Vacuum within the packaging must be preserved until the delivery to the subcontractor.
- **Anomaly during transport**
  Temperature recorders will be included in the packed rolls of pre-impregnated fabric. LLR will consult them and to verify that the product did not defrost during transport.
- **Management of the anomalies**
  Any noted anomaly will be recorded on a non-conformance report for disposition and corrective action.

As soon as the receiving inspection is performed, the product will be placed in a freezer at a temperature of –18°C. Any anomalies will be recorded and sent to LLR for disposition.

3.5 CONTROL OF PRE-IMPREGNATED FABRIC

The following tests will be carried out by the subcontractor before the first use of the rolls. The results of these control tests will be forwarded to the LLR.
Cutting of samples for control testing will be carried out by as described in the Section 4.

3.5.1 Checking of the tackiness

- Cut 2 samples of pre-impregnated fabric to dimensions 7.5cm (warp) X 2.5cm (weft), orientation 0°, after discarding the first layer of fabric surrounding the roll (initial full circumference of fabric from the roll).
- Remove the backing material from the first sample.
- Apply the first sample to a clean, dry aluminum test plate with a low pressure roller,
- Remove the second backing material from the first sample.
- Remove the second backing material from the second sample.
- Apply the second sample on top of the first sample.
- Remove the second backing material from the second sample.
- Position the plate vertically.
- Maintain in this position during 30 min at a temperature ranging between 21°C with 27°C.

Results:

Level 1	Low tackiness	Pre-impregnated fabric is stiff
Level 2		Pre-impregnated fabric is dry with a slight drape.
Level 3	Weak tackiness	The samples of pre-impregnated fabric are stuck together when hand-applied but do not stick to a vertically positioned plate.
Level 4	Acceptable tackiness	The samples of pre-impregnated fabric stick together and to the vertically positioned plate.
Level 5	Preferred tackiness	Pre-impregnated fabric sticks to hands with no resin transfer
Level 6	High tackiness	Pre-impregnated fabric and wet sloppy with resin transfer

The subcontractor will inform the LLR when the tackiness corresponds to level 3 or a lower level prior to further use of the material. Range for acceptance is Level 4 and Level 5.

3.5.2 Draping

- Cut 3 samples of pre-impregnated fabric to dimensions 7.5cm (warp) X 2.5cm (weft)
- Remove backing material from pre-impregnated fabric
- Drape 1 sample (side of 2.5cm) on a cylindrical bar of Ø 3.2mm and gently form the pre-impregnated fabric on the bar
- The fibers of the sample should not break or tear (inspect with microscope provided by the LLR). The specimen may be lightly heated
- Similarly drape and inspect the other two samples

All samples will be in non-conformance if any of the three samples fails the draping test.

3.6 Monitoring Log(in/Out Time) for Pre-impregnated Fabric

In order to enter the defrosted time and to determine the remaining lifespan of the pre-impregnated fabric, a monitoring log will accompany material at the time of each operation. It will be updated at each stage.

- Operation of the monitoring log:
  - Exit of pre-impregnated fabric from the freezer: the operator logs the date and time on the monitoring log
  - Entry of pre-impregnated fabric into the freezer: the operator logs the date and time, calculates the elapsed defrost time and subtracts that time from the pre-impregnated fabric lifespan recalculating the new lifespan.

The monitoring log, prepared by LLR, will have to accompany the product during the delivery to LLR.

1) Traveler cards, listing the detailed operation, will be prepared by LLR and supplied to the subcontractor for performing operations in sequence.
2) Completed traveler cards will be placed in a small pocket outside of the packing so that they are accessible without the need to open the packaging containing the pre-impregnated fabric.

4 CUTTING OF THE FABRIC

4.1 ENVIRONMENT

In order to minimize the exposure of pre-impregnated fabric to any source of contamination, handling and cutting of pre-impregnated fabric must be carried out in a clean room with controlled temperature and humidity (20°C ±2; HR<60%).

4.2 CLEANING OF THE CUTTING EQUIPMENT

All equipment which will be in contact with the pre-impregnated fabric must be cleaned with industrial alcohol and/or with acetone. Equipment includes, the surface of the cutting and handling tables, the blades and all the other tools which will be used for fabrication.

4.3 PRECAUTIONS FOR HANDLING

Only clean latex, powder-free gloves shall be used during handling to prevent contamination to the pre-impregnated fabric. If the gloves are soiled by a any product they must be changed before continuing handling of the pre-impregnated fabric.

Prior to initial use of the roll, the first layer of fabric surrounding the roll (initial full circumference of fabric from the roll) must be discarded.

When the roll is installed into its support for cutting, any object that could damage the carbon fibers must be clear of the roll.

4.4 CUTTINGS

Pre-impregnated cuttings are cut in accordance to the cutting plan and drawings.

To limit the defrosted time of the pre-impregnated fabric, all cutting required for one 50 m^2 roll will be carried out in a single operation (cuttings corresponding at least to 2 structures).

Plies which will not be used for lay-ups will be resealed, as described with the Section 7, and will be refrozen.

Plies used for the stack-up lay-up will not be refrozen before lay-up and compacting is complete (unless the duration between the operations is higher than 48 hours).

Recall: All operations (cuttings, compaction, stack-up, packing) performed on a single roll shall not exceed more than 10 days of the defrosted life for the pre-impregnated fabric.

The following tables specify cuttings for the simple plies and stack-ups required for a single composite structure. All data for in/out time of the pre-impregnated fabric shall be recorded on the monitoring log for each kit, as described in Section 7.

Formats for Simple Plies

Ref	Designation	Format (mm)	Orientation	Holes	Number of Plies
PEN	Mandrel Wrapping Ply	95x345	[45]	-	100
PIN	Interior Vertical Ply	20.7x345	[0]	-	90
PEAK	Interior Layer Ply	337x345	[0]	-	16
PLCA	Side Layer Ply - Type A	110x345	[45]	2 trous ϕ10	8
PLCB	Side Layer Ply - Type B	110x345	[45]	3 trous ϕ10	8
PEC	External Layer Ply	248x345	[45]	-	16
PHI	Interior Horizontal Ply	337x337	[0]	-	7

1. **General tolerance of cutting: ±0.2 mm**
2. **For the rectangular formats, the warp of the fabric must be aligned with the largest dimension**

Formats for stack-ups

Ref	Designation	Format (mm)	Orientation [0]	Orientation [45]	Holes	Nnumber of Stack
ELA	Side Stack-Up - Type A	20.7x337	4 plies	4 plies	2 holes ϕ10 mm	8
ELB	Side Stack-Up - Type B	20.7x337	5 plies	4 plies	3 holes ϕ10 mm	8
ELAB	Side Stack-Up -Type AB	20.7x337	5 plies	4 plies	-	16
ES1	Top Stack-Up 1	337x337	4	4	16 square holes 12 mm	1
ES2	Top Stack-Up 2	337x337	4	4	16 holes ϕ6 mm	1
EI1	Bottom Stack-Up 1	337x337	9	8	25 square holes 18 mm	1
EI2	Bottom Stack-Up 2	337x337	9	8	25 holes ϕ8 mm	1

1. **General tolerance of cutting: ±0.2 mm.**
2. **Stack-ups must be assembled so that warp and weft direction for all plies is aligned (0° and 45°).**
3. **For the rectangular formats, the warp of the fabric must be aligned with the largest dimension**

5 STACK-UPS

5.1 ENVIRONMENT

In order to minimize the exposure of pre-impregnated fabric to any source of contamination, stack-ups of pre-impregnated fabric must be carried out in a Class 100 000 clean room, which is temperature and humidity controlled (20°C ±2; RH<60%).

Recall: moisture is harmful to pre-impregnated fabric.

5.2 CLEANING OF THE MATERIEL

All of the material and working surface which is in contact with pre-impregnated fabric must be cleaned with acetone and/or industrial alcohol.

5.3 PRECAUTIONS OF HANDLING

The handling of pre-impregnated fabric must be done with clean, powder-free, latex gloves in order to avoid any source of contamination.
If the gloves are soiled by a product, they must be changed.

5.4 STACK-UPS

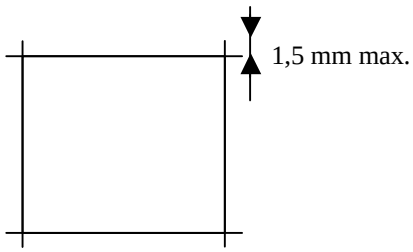
The stack-up of the cut plies will be carried out following cutting, without refreezing of the plies (unless the duration between the two operations is higher than 48 hours).
If is necessary, the plies will have to be repacked and hermetically sealed.

All operations (cuttings, compaction, stack-up, packing) performed on a single roll shall not exceed more than 10 days of the defrosted life for the pre-impregnated fabric.

Stack-ups are carried out in the order indicated in the following tables.
Each stack-up will be vacuum-compacted for 10 minutes.

A great importance will be given to the order of stack-up of the plies of different orientations. A representative of the LLR will be required at the time when the initial stack-ups are performed.

- △ During the stack-up of the various plies, removal of the backing material from each ply, the state of cleanliness of the ply, visual inspection of the ply for any defects, must be verified each time. Material with unacceptable defects should be segregated until a decision to address the defect is agreed upon
- △ The external edges of stack-ups and interior cuttings (round holes and square holes) must be well aligned so that no misalignment between the plies will cause interference with the fixtures and tooling.
- △ The square holes must not present notches higher than 1.5mm, as shown below.



5.4.1 Lower Stack-Up 1

To facilitate the operations of cutting, plies could be prepared, cut out then stacked. The stack-up must meet the following requirements:

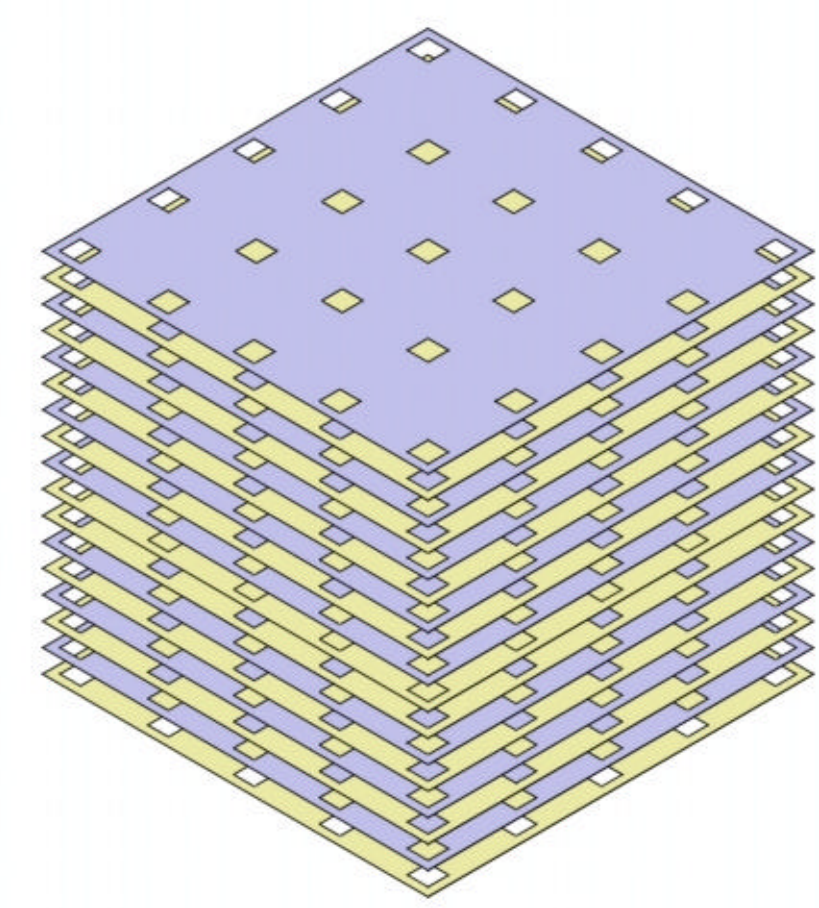
- The plies are perfectly aligned (interior cuttings and external rows)
- The order of stack-up and the orientation of stack-up of the plies are correct, as shown below
- In process visual inspection must be performed during the stack-up process
- Tooling must be used for proper alignment

Markings on the backing sheet of each ply will be used to avoid error during stack-up (see Section 7.1.2)

EI1	**1 Stack**

17 Total Plies

- 9 Plies [0°]
- 8 Plies [45°]
- 25 Square Holes, 18mm x 18 mm



Ply ID#	Orientation
1	[45]
2	[0]
3	[45]
4	[0]
5	[45]
6	[0]
7	[45]
8	[0]
9	[45]
10	[0]
11	[0]
12	[45]
13	[0]
14	[45]
15	[0]
16	[45]
17	[0]

In blue: warp of ply oriented at 45°

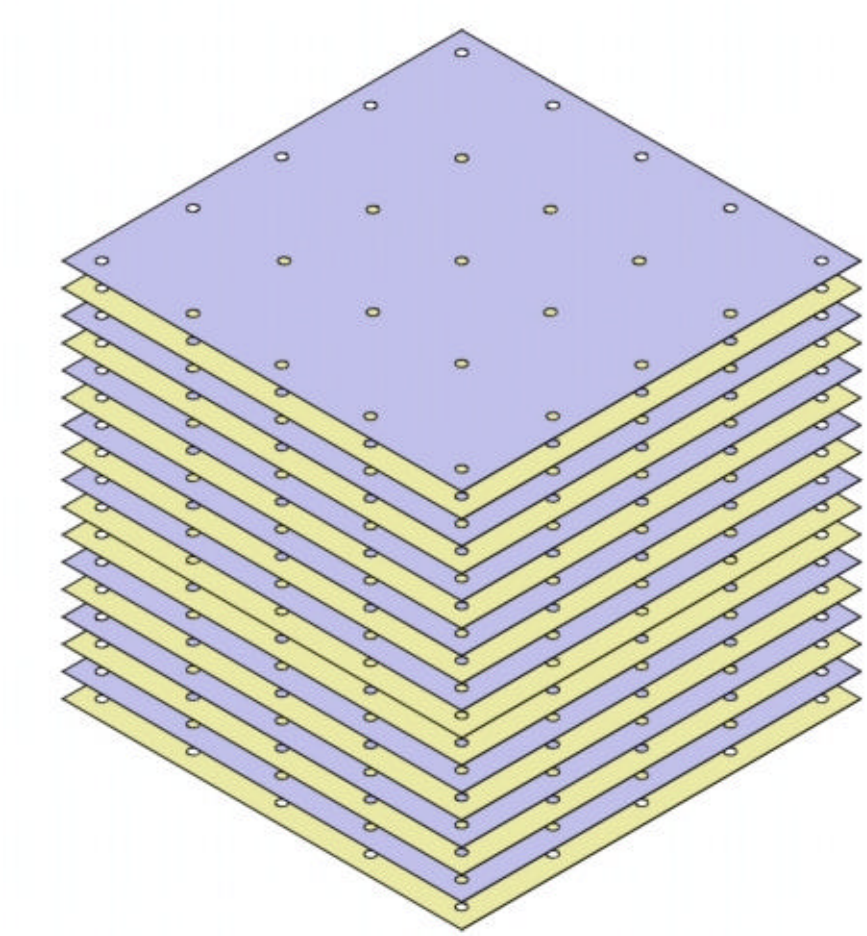
In yellow: warp of ply oriented at 0°

5.4.2 Lower Stack-Up 2

The same remarks for EI1 also apply to EI2. Stack-up is identical.

EI2 — **1 Stack**

17 Total Plies
- 9 Plies [0°]
- 8 Plies [45°]
- 25 Round Holes, ϕ8 mm Diameter



Ply ID#	Orientation
1	[45]
2	[0]
3	[45]
4	[0]
5	[45]
6	[0]
7	[45]
8	[0]
9	[45]
10	[0]
11	[0]
12	[45]
13	[0]
14	[45]
15	[0]
16	[45]
17	[0]

In blue: warp of ply oriented at 45°

In yellow: warp of ply oriented at 0°

5.4.3 Higher Stack-Up_1

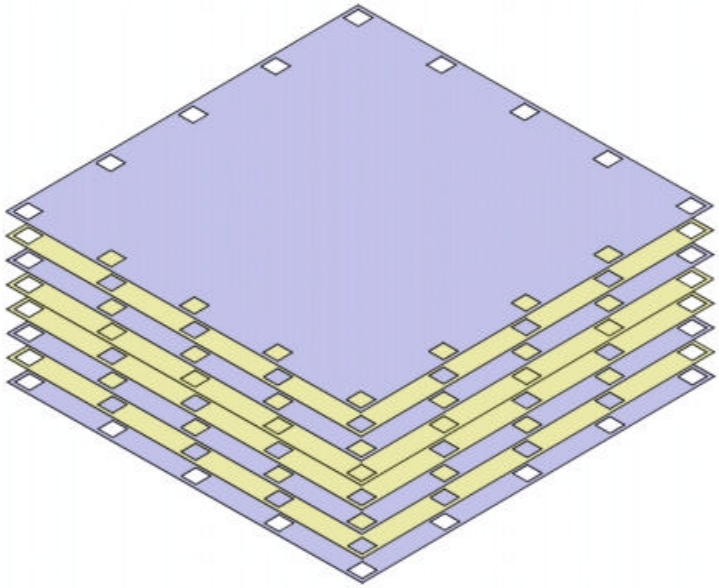
To facilitate the operations of cutting, two elements could be prepared beforehand (stack-up and cutting of 4 plies per element). The stack-up must meet the following requirements:

- The plies are perfectly aligned (interior cuttings and external rows)
- The order of stack-up and the orientation of stack-up of the plies are correct
- In process visual inspection must be performed during the stack-up process
- Tooling must be used for proper alignment

Markings on the backing sheet of each ply will be used to avoid error during stack-up (see Section 7.1.2)

ES1 — **1 stack**

8 Total Plies
- 4 Plies [0°]
- 4 Plies [45°]
- 16 Square Holes, 12 mm x 12 mm



Ply ID#	Orientation
1	[45]
2	[0]
3	[45]
4	[0]
5	[0]
6	[45]
7	[0]
8	[45]

In blue: warp of ply oriented at 45°

In yellow: warp of ply oriented at 0°

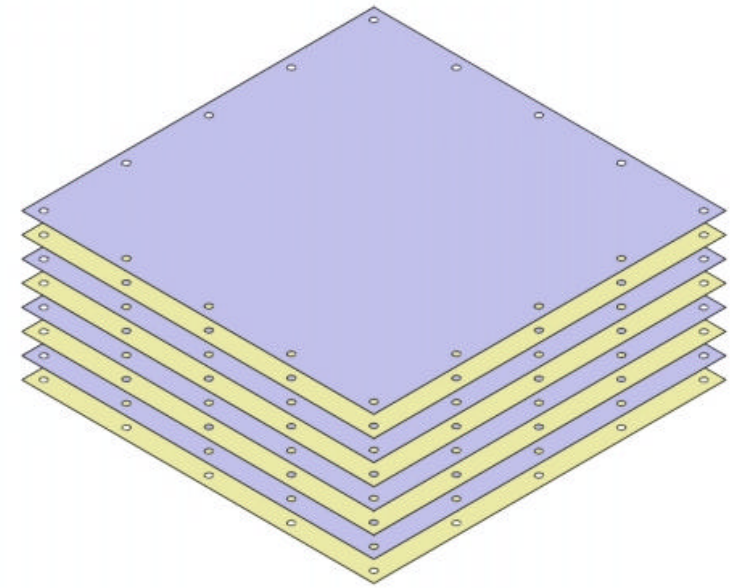
5.4.4 Higher Stack-Up 2

To facilitate the operations of cutting, two elements could be prepared beforehand (stack-up and cutting of 4 plies per element). The stack-up must meet the following requirements:

- The plies are perfectly aligned (interior cuttings and external rows)
- The order of stack-up and the orientation of stack-up of the plies are correct
- In process visual inspection must be performed during the stack-up process
- Tooling must be used for proper alignment

Markings on the backing sheet of each ply will be used to avoid error during stack-up (see Section 7.1.2)

ES2	**1 Stack-up**
8 Total Plies • 4 Plies [0°] • 4 Plies [45°] • 16 Round Holes, ϕ6 mm Diameter	



Ply ID#	Orientation
1	[45]
2	[0]
3	[45]
4	[0]
5	[45]
6	[0]
7	[45]
8	[0]

In blue: warp of ply oriented at 45°

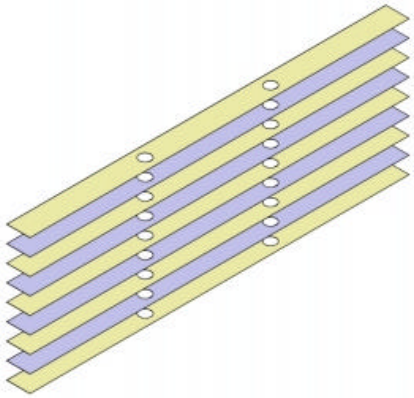
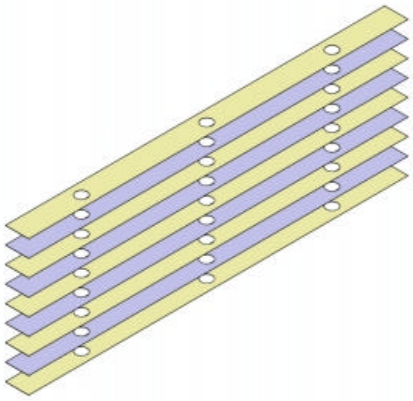
In yellow: warp of ply oriented at 0°

5.4.5 Side Stack-Ups - Type A and B

To facilitate the operations of cutting, plies could be prepared, cut out then stacked. The stack-up must meet the following requirements:

- The plies are perfectly aligned (interior cuttings and external rows)
- The order of stack-up and the orientation of stack-up of the plies are correct
- In process visual inspection must be performed during the stack-up process
- Tooling must be used for proper alignment

Markings on the backing sheet of each ply will be used to avoid error during stack-up (see Section 7.1.2)

<table>
<tr><th>ELA</th><th>ELB</th><th colspan="2">8+8 Stacks</th></tr>
<tr><td>• 9 Total Plies
o 5 Plies [0°]
o 4 Plies [45°]
• 2 Perçages, ϕ10 mm Diameter</td><td>• 9 Total Plies
o 5 Plies [0°]
o 4 Plies [45°]
• 3 Perçage, ϕ10 mm Diameter</td><td colspan="2">Même sequence for ELA and ELB</td></tr>
<tr><td rowspan="10">  </td><td rowspan="10">  </td><td>N° pli</td><td>Orientation</td></tr>
<tr><td>1</td><td>[0]</td></tr>
<tr><td>2</td><td>[45]</td></tr>
<tr><td>6</td><td>[0]</td></tr>
<tr><td>4</td><td>[45]</td></tr>
<tr><td>5</td><td>[0]</td></tr>
<tr><td>6</td><td>[45]</td></tr>
<tr><td>7</td><td>[0]</td></tr>
<tr><td>8</td><td>[45]</td></tr>
<tr><td>9</td><td>[0]</td></tr>
<tr><td colspan="4">In blue: warp of ply oriented at 45°
In yellow: warp of ply oriented at 0°</td></tr>
</table>

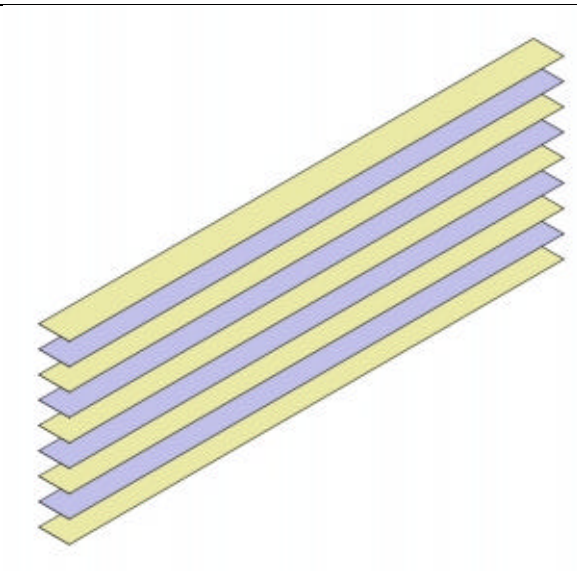
5.4.6 Side Stack-Up - Standard AB

To facilitate the operations of cutting, plies could be prepared, cut out then stacked. The stack-up must meet the following requirements:

- The plies are perfectly aligned (interior cuttings and external rows)
- The order of stack-up and the orientation of stack-up of the plies are correct
- In process visual inspection must be performed during the stack-up process
- Tooling must be used for proper alignment

Markings on the backing sheet of each ply will be used to avoid error during stack-up (see Section 7.1.2)

ELAB	**16 Stacks**
9 Total Plies • 5 Plies [0°] • 4 Plies [45°]	



Ply ID#	Orientation
1	[0]
2	[45]
3	[0]
4	[45]
5	[0]
6	[45]
7	[0]
8	[45]
9	[0]

In blue: warp of ply oriented at 45°

In yellow: warp of ply oriented at 0°

6 ADDRESSING NON-CONFORMITY

When a variation in conformance is noted, the following must occur:

- Immediately inform, in writing, to LLR
- Note defects using the existing procedure of the subcontractor (procedure will be validated beforehand by the LLR)

The material associated with an anomaly must be immediately identified and isolated in a well-marked separate area to avoid mix-up while a resolution is being made.
The LLR will resolve the anomaly and report on the resolution for “use as is”, “scrap”, or “rework”, depending upon the type of defect.

The product cannot be shipped until corrective action is implemented and the problem is resolved.

7 SOURCE INSPECTION AND RANDOM INSPECTION BY LLR

LLR will perform source inspection of the plies and stack-up associated with the first two composite structure builds and will perform random audit to verify the processes and inspections as defined.

8 CONDITIONING, STORAGE AND FORWARDING

8.1 PACKING AND MARKING

8.1.1 Packing

All simple plies and stack-ups must be packed in a clean environment.
All packing products and labels must be compatible with Class 100,000 clean room environment.

All plies and stack-ups necessary to the manufacture a single structure must be organized as a kit, as defined herein. The supply will be carried out in 18 kits, corresponding to the 18 composite structures for manufacture. Within each kit, each type of ply and stack-up will be individually packed and marked.

Each individual kit will contain the number of plies or stack-ups indicated below

- 1 Lower Stack-Up 1 (EI1)
- 1 Lower Stack-Up 2 (EI2)
- 1 Top Stack-Up 1 (ES1)
- 1 Top Stack-Up 2 (ES2)
- 8 Side Stack-Ups - Type A (ELA)
- 8 Side Stack-Ups - Type B (ELB)
- 16 Side Stack-Ups - Type AB (ELAB)
- 100 Mandrel Wrapping Plies (PEN)
- 90 Vertical Interior Ply (PIN)
- 16 Interior Layer Ply (PEAK)
- 8 Side Layer Ply – Type A (PLCA)
- 8 Side Layer Ply – Type B (PLCB)
- 16 External Layer Ply (PEC)
- 7 Interior Horizontal Ply (PHI)

The types of plies and stack-up are packed in transparent plastic envelopes, which are sealed using a sealing machine and frozen at –18°C
Les types de plis et empilements seront ensachés dans **deux enveloppes plastiques transparentes** closed hermetically using a welding machine then conditioned with –18°C.
Any packing closed by Scotch tape will be in non-conformance.
Packing must be sealed to fulfill the following requirements:

- the maintenance of cleanliness
- protection against moisture

The various types of plies and stack-ups, which are as a kit, will have to be packed flat so that they are supported on all surfaces to avoid bending.
The plies and stack-ups must not be deformed or stuck to each other.

8.1.2 Labelling and Marking

8.1.2.1 Labelling

A label will be affixed on the interior package of each type of plies and stack-up.
Following information will have to appear in it:

- For the simple plies
  - Name of the plies
  - Quantity of plies in the package
- For stack-ups:
  - Name of stack-up

- Quantity of stack-up in the package

8.1.2.2 Marking

Any marking that must be made to the plies or stack-ups of pre-impregnated fabric, can only be done on the backing sheet, not directly on the pre-impregnated fabric. This marking can only be made using a felt marker.

8.2 STORAGE

8.2.1 Storage of the Rolls

When not in use, the rolls must be stored in a freezer at –18°C. The rolls must not rest against other pre-impregnated fabric or any object which can damage the roll.

8.2.2 Storage of the Simple Plies

Once cut, the simple plies must be hermetically sealed and refrozen at –18°C. When the plies are stored outside of the freezer, the plies must be stored flat so that pre-impregnated fabric does not become deformed.

8.2.3 Storage of Stack-ups

Between two operations, the plies used for stack-ups must stored flat so that the pre-impregnated fabric does not become deformed. These plies must also be protected with clean plastic film to limit any contamination.
During the transfer from the cutting room to the clean room to produce the stack-ups, the plies must be protected by a clean plastic film.
Once the stack-ups are assembled, they are hermetically packed and and refrozen at –18°C. Stack-ups must be stored flat in the freezer.

8.3 DELIVERY

During the delivery, cuttings and stack-ups will be organized as a kit for each structure. For example, for each structure, a kit includes:

- 1 Lower Stack-Up 1 (EI1)
- 1 Lower Stack-Up 2 (EI2)
- 1 Top Stack-Up 1 (ES1)
- 1 Top Stack-Up 2 (ES2)
- 8 Side Stack-Ups - Type A (ELA)
- 8 Side Stack-Ups - Type B (ELB)
- 16 Side Stack-Ups - Type AB (ELAB)
- 100 Mandrel Wrapping Plies (PEN)
- 90 Vertical Interior Ply (PIN)
- 16 Interior Layer Ply (PEAK)
- 8 Side Layer Ply – Type A (PLCA)
- 8 Side Layer Ply – Type B (PLCB)
- 16 External Layer Ply (PEC)
- 7 Interior Horizontal Ply (PHI)

All delivered products (plies, stack-ups, rolls) will have to be accompanied with the following:

- Corresponding monitoring logs (in/out logs). These sheets will have the information referenced in Section 3.5. The remaining lifespan must be calculated and noted on the sheet for each product.
- Nonconformance reports

The quality of packaging must protect the finished parts from fading.
Packaging will have instructions stating that it can only be opened in a clean room environment.
Moreover one visible label will be applied to packaging, which indicates "Place in Freezer Immediately Upon Receipt".
Transporation of the pre-impregnated fabric plies from the subcontractor to the LLR will take place in a refrigerated truck or in a isothermal packing (with dry ice, for example) to guarantee the products will not defrost during delivery.

The products will be delivery to the following address:

Ecole Polytechnique - Laboratoire Leprince Ringuet
Ateliers Centraux
Route de Saclay- 91128 Palaiseau